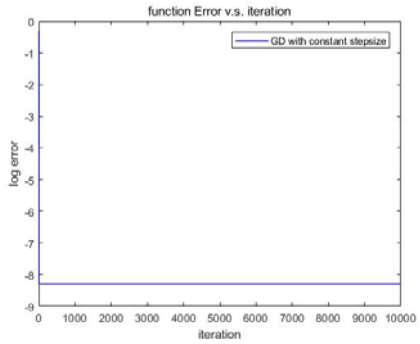
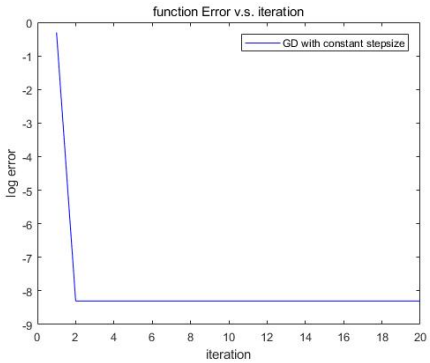
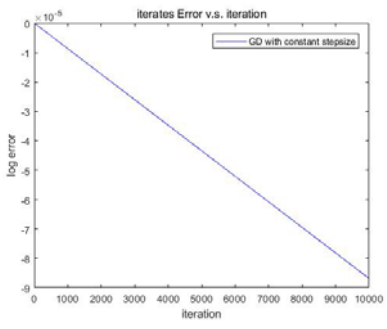
Problem 2 (i)

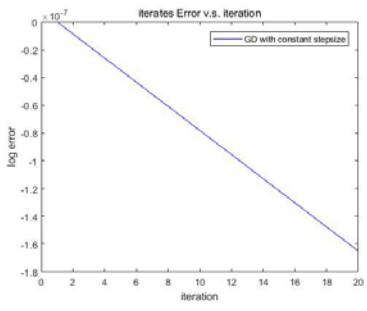
Code: (comments：% means change to another line)

```
Q=[1,0;0,10^(-8)];x=[1;1];max_it=10^4;%
cur_ite_error=x'*x;error_ite=zeros(max_it+1,1);erro_ite(1)=log10(cur_ite_error);%
cur_func_error=0.5*x'*Q*x;error_func=zeros(max_it+1,1);error_func(1)=log10(cur_func_error);%
alpha=1;
ite=1;
while(ite<=max_it)%
   x_0=x-[x(1);x(2)*10^(-8)];
   x=x_0;
   error_ite(ite+1)=log10(x'*x);
   error_func(ite+1)=log10(0.5*x'*Q*x);
   ite=ite+1;
end
figure;%
plot_length=max_it;%
plot_vet=1:1:plot_length;%
plot(plot_vet,error_func(1:plot_length),'b-');%
xlabel('iteration');%
ylabel('log error');%
legend('GD with constant stepsize');%
title('function Error v.s. iteration');
figure;%
plot_length=max_it;%
plot_vet=1:1:plot_length;%
plot(plot_vet,error_ite(1:plot_length),'b-');%
xlabel('iteration');%
ylabel('log error');%
legend('GD with constant stepsize');%
title('iterates Error v.s. iteration');
```



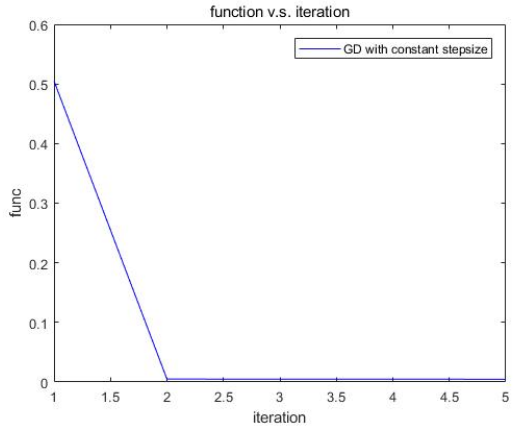


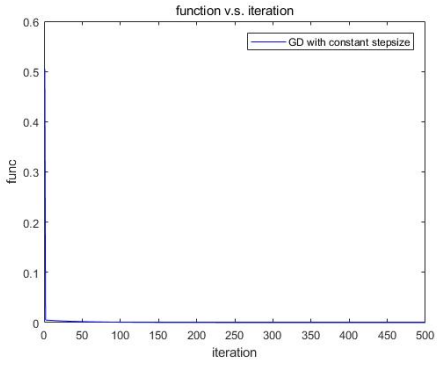


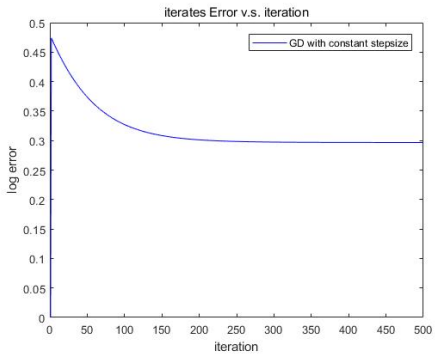


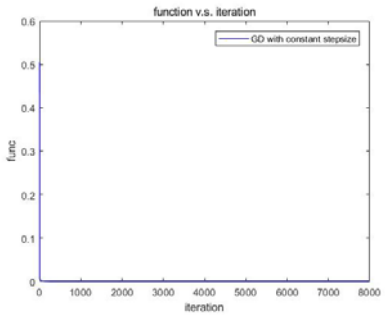
Problem 2 (iii) code:

```
Q=[1,0,0,0;0,10^(-2),0,0;0,0,10^(-4),0;0,0,0,10^(-6);];x=[1;1;1;1;];max_it=5;%
cur_ite_error=x'*x;error_ite=zeros(max_it+1,1);erro_ite(1)=log10(cur_ite_error);%
cur_func_error=0.5*x'*Q*x;error_func=zeros(max_it+1,1);error_func(1)=log10(cur_func_error);%
alpha=1;
ite=1;
while(ite<=max_it)%
   x_0=x-[x(1);x(2)*10^(-2);x(2)*10^(-4);;x(2)*10^(-6)];
   x=x_0;
   error_ite(ite+1)=log10(x'*x);
   error_func(ite+1)=log10(0.5*x'*Q*x);
   cur_func_error(ite+1)=0.5*x'*Q*x;
   ite=ite+1;
end
title('iterates Error v.s. iteration');
%% just for refer

figure;%
plot_length=max_it;%
plot_vet=1:1:plot_length;%
plot(plot_vet,cur_func_error(1:plot_length),'b-');%
xlabel('iteration');%
ylabel('func');%
legend('GD with constant stepsize');%
title('function v.s. iteration');
```





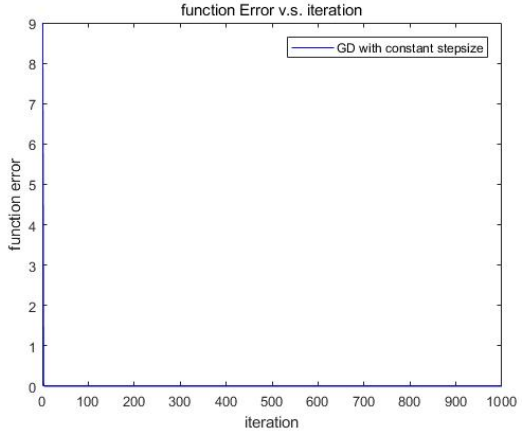


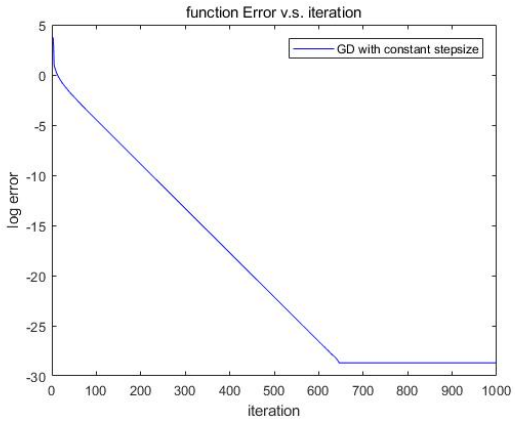


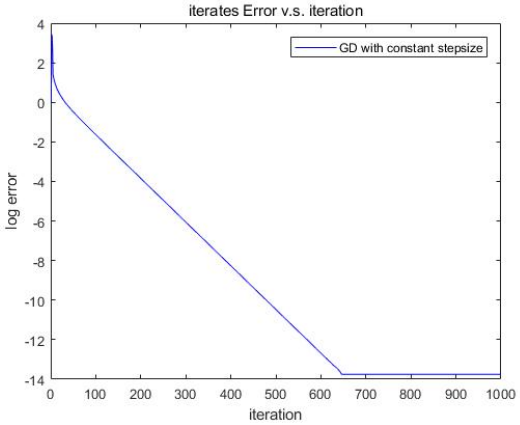
Problem 3 (v)

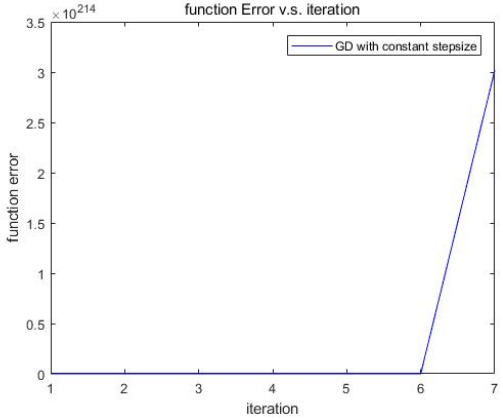
Code:

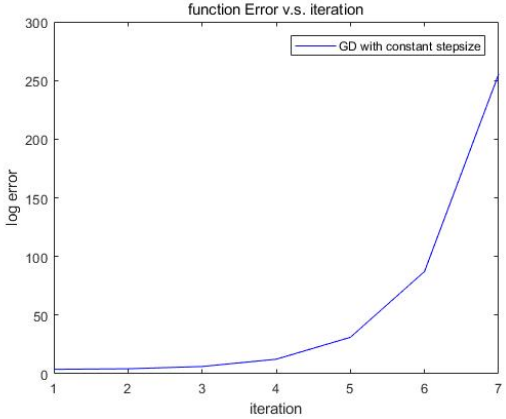
```
x=9;max_it=10^3;%
cur_ite_error=4*x^3-4*x;error_ite=zeros(max_it+1,1);erro_ite(1)=log10(cur_ite_error);%
cur_func_error=(x^2-1)^2;error_func=zeros(max_it+1,1);error_func(1)=log10(cur_func_error);%
alpha=7/(12*x^2-4);
ite=1;
while(ite<=max_it)%
   x_0=x-alpha*(4*x^3-4*x);
   x=x_0;
   error_ite(ite+1)=log10(4*x^3-4*x);
   error_func(ite+1)=log10((x^2-1)^2);
   cur_func_error(ite+1)=(x^2-1)^2;
   ite=ite+1;
end

figure;%
plot_length=max_it;%
plot_vet=1:1:plot_length;%
plot(plot_vet,error_func(1:plot_length),'b-');%
xlabel('iteration');%
ylabel('log error');%
legend('GD with constant stepsize');%
title('function Error v.s. iteration');

figure;%
plot_length=max_it;%
plot_vet=1:1:plot_length;%
plot(plot_vet,error_ite(1:plot_length),'b-');%
xlabel('iteration');%
ylabel('log error');%
legend('GD with constant stepsize');%
title('iterates Error v.s. iteration');

figure;%
plot_length=max_it;%
plot_vet=1:1:plot_length;%
plot(plot_vet,cur_func_error(1:plot_length),'b-');%
xlabel('iteration');%
ylabel('function error');%
legend('GD with constant stepsize');%
title('function Error v.s. iteration');
```

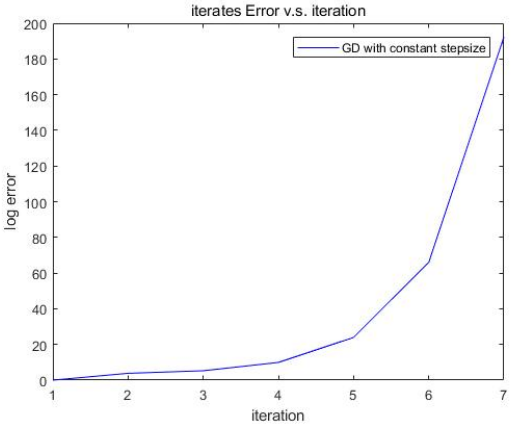

function Error v.s. iteration
GD with constant stepsize
function error
iteration

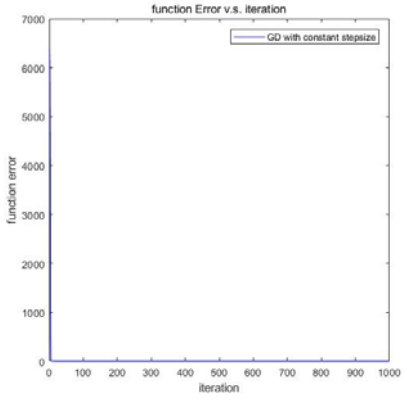

function Error v.s. iteration
GD with constant stepsize
log error
iteration

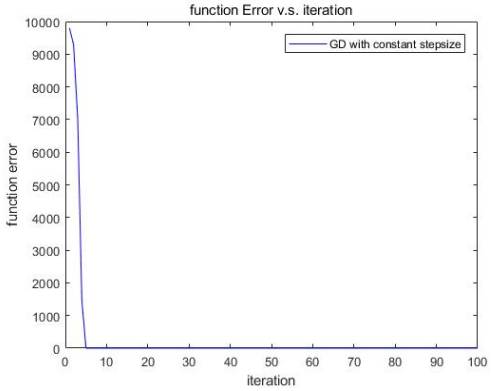

iterates Error v.s. iteration
GD with constant stepsize
log error
iteration

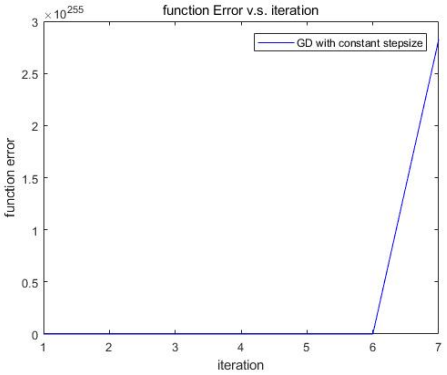

function Error v.s. iteration
GD with constant stepsize
function error
iteration

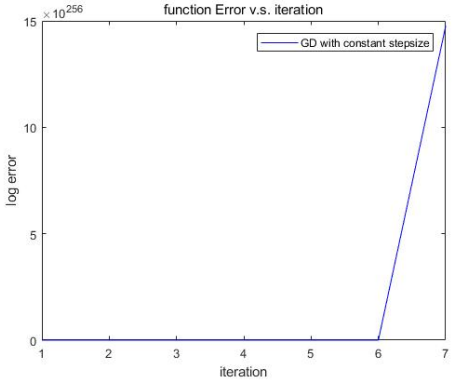

function Error v.s. iteration
GD with constant stepsize
log error
iteration


iterates Error v.s. iteration
GD with constant stepsize
log error
iteration


function Error v.s. iteration
GD with constant stepsize
function error
iteration


function Error v.s. iteration
GD with constant stepsize
function error
iteration

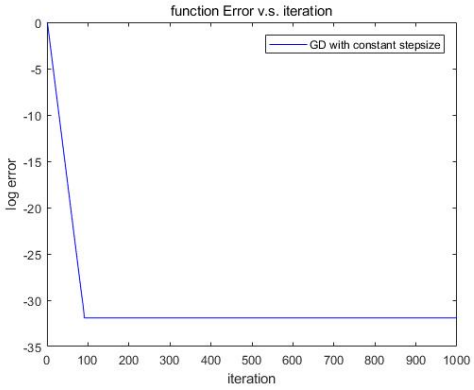

function Error v.s. iteration
GD with constant stepsize
function error
iteration

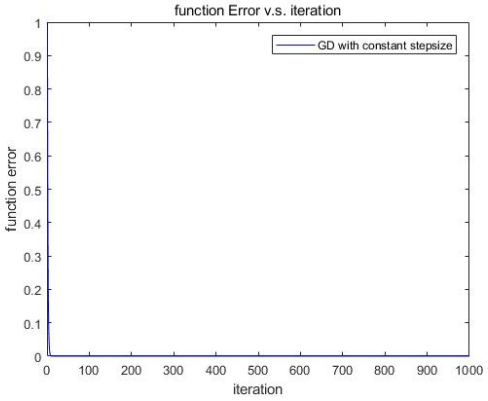

function Error v.s. iteration
GD with constant stepsize
log error
iteration

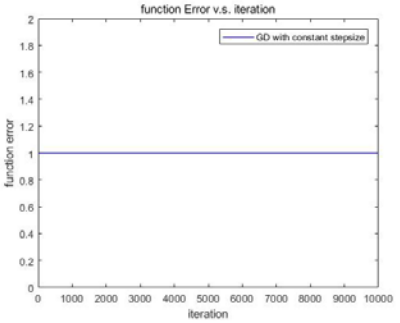
Problem 4 (iii)

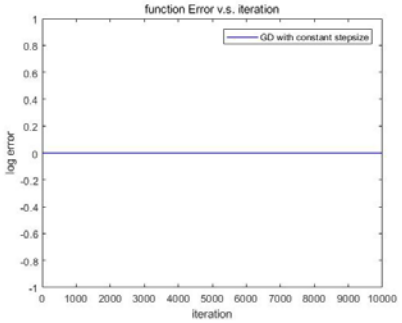
Code:

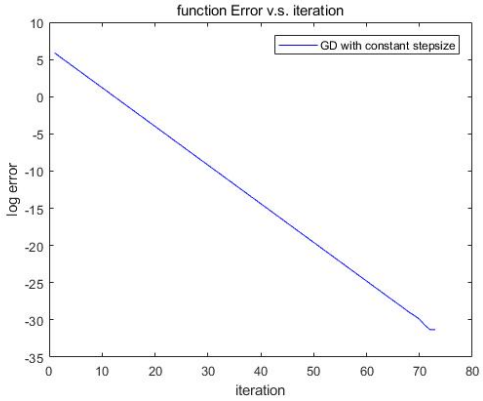
```
x=100*rand(1)+0;y=100*rand(1)+1;max_it=10^4;%
cur_ite_error=2*x*y^2-2*y;error_ite=zeros(max_it+1,1);erro_ite(1)=log10(cur_ite_error);%
cur_func_error=(x*y-1)^2;error_func=zeros(max_it+1,1);error_func(1)=log10(cur_func_error);%
alpha=8/(2*(x^2+y^2+abs(4*x*y-2)));
ite=1;
while(ite<=max_it)%
   x_0=x-alpha*(2*x*y^2-2*y);
   x=x_0;
   y_0=y-alpha*(2*y*x^2-2*x);
   error_func(ite+1)=log10((x*y-1)^2);
   cur_func_error(ite+1)=(x*y-1)^2;
   ite=ite+1;
end

figure;%
plot_length=max_it;%
plot_vet=1:1:plot_length;%
plot(plot_vet,error_func(1:plot_length),'b-');%
xlabel('iteration');%
ylabel('log error');%
legend('GD with constant stepsize');%
title('function Error v.s. iteration');


figure;%
plot_length=max_it;%
plot_vet=1:1:plot_length;%
plot(plot_vet,cur_func_error(1:plot_length),'b-');%
xlabel('iteration');%
ylabel('function error');%
legend('GD with constant stepsize');%
title('function Error v.s. iteration');
```

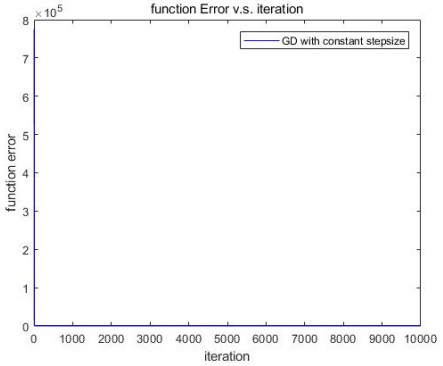

function Error v.s. iteration
GD with constant stepsize
log error
iteration

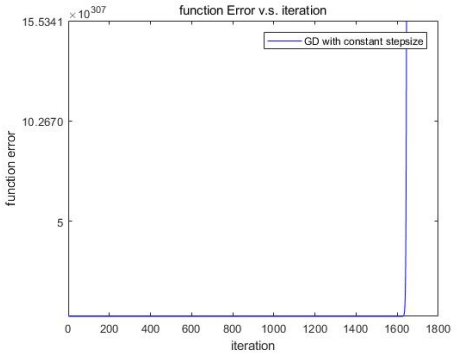

function Error v.s. iteration
GD with constant stepsize
function error
iteration

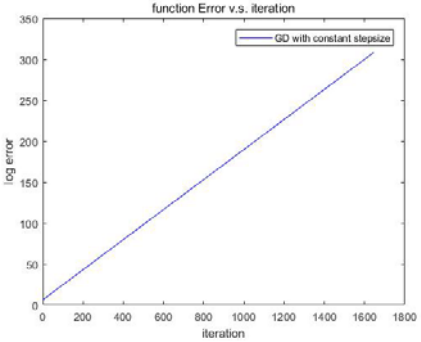

function Error v.s. iteration
GD with constant stepsize
function error
iteration


function Error v.s. iteration
GD with constant stepsize
log error
iteration

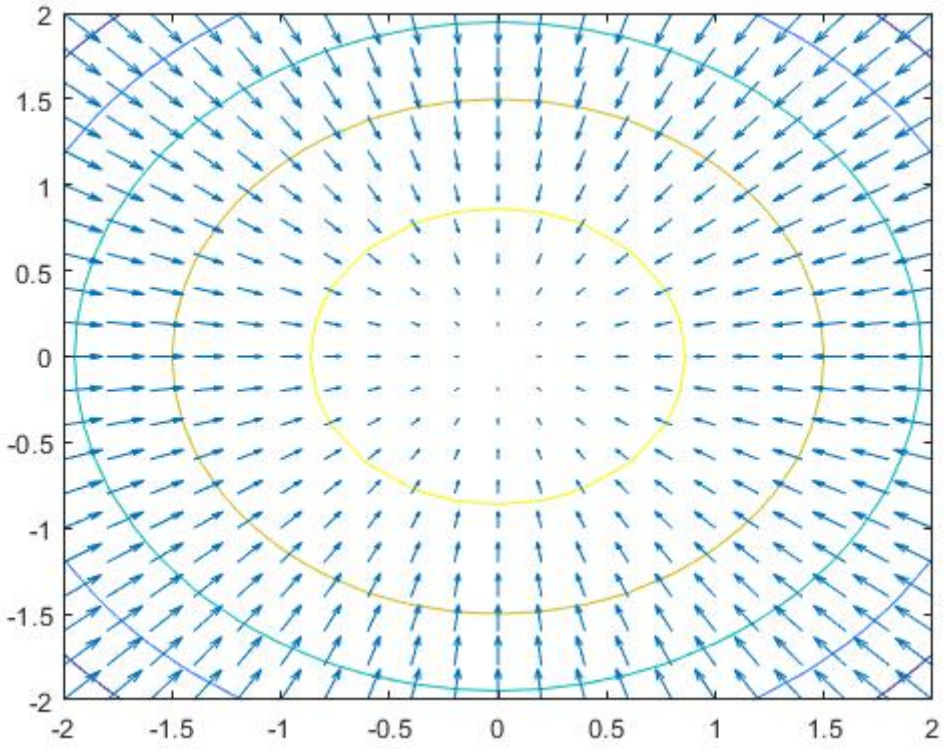

function Error v.s. iteration
GD with constant stepsize
log error
iteration


function Error v.s. iteration
GD with constant stepsize
function error
iteration


function Error v.s. iteration
GD with constant stepsize
function error
iteration


function Error v.s. iteration
GD with constant stepsize
log error
iteration

Problem 4 (iV)

Code:

```
[X,Y] = meshgrid(-2:.2:2);
Z =1./(2*(X.^2+Y.^2+abs(4*X*Y-2)));
[DX,DY] = gradient(Z,.2,.2);

figure
contour(X,Y,Z)
hold on
quiver(X,Y,DX,DY)
hold off
```